THE AUDIO LEAGUE REPORT

PLEASANTVILLE , N.Y. OCTOBER 1954 Vol. 1 No. 1 Price 35¢

WHY AN AUDIO LEAGUE ?

Since World War II, the introduction of long-playing records and the spread of FM broadcasting has awakened tremendous interest in high-fidelity reproduction of music in the home. The extent of this interest is clearly indicated by the number of books and magazines devoted solely to hi-fi, and by the multi-million-dollar annual business in high-fidelity equipment. As in any expanding market, competition for the consumer's dollars brings out new models, new companies, new claims. The individual desirous of assembling a new system, or of improving his old system, is completely bewildered by the sheer number of components which he must investigate before buying. The problem of combining these components into a compatible system is possibly even greater. And there is always the fear that tomorrow will bring some new technique that will completely obsolete today's equipment.

In the face of all the problems which exist for anyone interested in audio for the home, there is lacking a source of accurate, unbiased information devoted to the solution of such problems. The sources of information in the audio field are the manufacturers, the magazines, the distributors and retailers, and the existing consumer organizations.

The manufacturers of audio equipment distribute attractive literature and also advertise in the popular magazines. A small number of these manufacturers publish reasonably accurate statements about their products, and these manufacturers are excellent sources of information concerning their products; the practical difficulty lies in distinguishing these manufacturers from the others. A large number of manufacturers publish claims which range from mild to wild in their exaggerations. This does not mean that these products are necessarily inferior. Conversely, while it is true that the manufacturers who exaggerate least do, in general, turn out products of high quality, they also occasionally market inferior products. The purchase of 'name brand' equipment is thus no guarantee of quality, while some of the mass-producers of generally low-quality equipment have sometimes marketed an excellent item.

The popular magazines are designed to satisfy the interests of a diversified readership, and are frequently filled with human interest articles, information on home construction of mediocre equipment designed by hack writers, and boring repetitions of the most obvious elementary facts and platitudes. Some of these publications completely lack prespective concerning the average audio consumer's financial and technical capabilities. Some of the magazines run equipment reports, but these magazines also print advertising on the same products. These reports are often amazingly good, but there have been few cases in which equipment was more than mildly criticised. It is possible to avoid offending advertisers and at the same time to have reports which are individually honest, by reporting only on acceptable aspects of equipment. Such a policy is of limited service to the consumer.

The distributors and retailers must keep merchandise moving, and they therefore tend to push slow items and items on which their mark-up is greater. Many of the sales personnel are not highly qualified, though they will make recommendations with great assurance. It must be admitted, however, that many of the sales personnel are qualified, having availed themselves fully of the opportunity to examine and listen to all the equipment they sell, and can give valuable advice. The question is, as with the honest manufacturers, who are the qualified ones?

The consumers' organizations cannot expend the same time, effort and editorial space on their audio equipment reports as they expend on food, clothing, household products and automobiles; they must serve the basic needs of an extremely large membership. Their audio reports are too infrequent to satisfy the group strongly interested in such things. It is unfortunate that whatever audio reports they do publish are presented in the same fashion as reports on canned goods, and are often quite arbitrary in their ratings It must be admitted that the informative articles which accompany their reports are excellent being far superior to equivalent articles in the popular magazines.

This, then, is the summary of existing sources; incomplete and/or inaccurate. Clearly, a new source is needed, devoted solely to audio, capable of providing complete and accurate information, and immune to pressures.

THE ORGANIZATION

The founders of The Audio League are a group of engineers, musicians and hobbyists who are actively interested in high-fidelity recording and reproduction of sound. This group has been in existence for several years, meeting to discuss technical problems, to test audio equipment, and to listen to music. Listening has brought personal pleasure, but testing has brought knowledge, in the form of tables, graphs, charts and the averaged responses of listening panels.

As our knowledge grew, so did our realization of the amount of bunk and confusion which exist in the audio field. We became aware of our unique position in the possession of facts, and we became aware of the plight of the thousands who had no way of obtaining these facts. The Audio League was therefore founded, to share our knowledge, and to make possible activities of a wider scope. Our purpose is to inform and protect the owner, buyer and builder of audio equipment for the home. Our principal activities will be the testing of equipment and the publishing of reports on these tests. We will, of course, cover the related matters of interest in the audio field, in our desire to provide a reasonably complete information service.

Not one member of our staff is employed by or is in any way connected with a manufacturer, distributor or retailer of audio equipment, or is financially interested in the sale of any particular makes of audio equipment.

It must be stated at the outset that we do not consider ourselves perfect or omniscient. Measurements are liable to error. Facts are subject to interpretation. We shall make our tests as accurately and thoroughly as possible, and present our results as clearly and impartially as we can. Where we have formed opinions in the process of examining and listening to the equipment we test, we shall present those opinions for your consideration. We hope and think that our opinions are reasonable, and we shall strive to keep them so; but we shall always identify the facts and the opinions so that you can tell them apart.

As The Audio League grows in membership, and as it gains respect for the quality and integrity of its work, it will become a 'clearing house' for all kinds of information; correspondence from members describing their experience with their equipment, statements from manufacturers, the confidences of salesmen, etc. The kind, amount and value of this information that we will receive will depend greatly on the way we conduct our affairs. We pledge to be honest, forthright and fair, to speak without fear, favoritism or arbitrariness. Our members will know that they can believe what we print, and the manufacturers of decent equipment will realize that they need not fear our existence.

The Audio League Report will be a staff effort. Where opinions are presented, they will be those which are unanimous; otherwise we shall present both majority and minority opinions. Individual articles, other than equipment reports, may carry by-lines; we encourage authorship. We welcome information from our readers about the performance of their own equipment, because the durability and long-term performance of equipment is extremely difficult to test. But we request our readers to understand that we cannot answer individual letters, or provide free private consultations. The limitations of time and economics forbids the performance of such personal services.

THE SERVICE

If a consumers' research organization were to present only reports on equipment tested, it would be performing a fine service and yet an inadequate one. The audio consumer has many other problems besides that of knowing the quality of any particular make of equipment. He may have questions like the following: (These are presented as examples only, for the present.)

1. "Can I get a good system for two-hundred dollars?"
2. "I have three-hundred dollars to spend; how shall I apportion it among the various components so as to get the best overall results for my money?"
3. "I don't have a system yet, and I was planning to buy one; but all the ads on tape machines and pre-recorded tapes make me wonder if I shouldn't hold off, because records will become obsolete."
4. " I have a tiny apartment with very little space and no corners; what can I do?"
5. "Should I get a pre-amp, or do those new ceramic cartridges, with their high-level output already equalized, make it unnecessary?"
6. "I thought I knew what I wanted, but after reading the ads and visiting the dealers, I don't know what I want."
7. "I have a friend who's an engineer, and he says..."
8. "My wife says..."

The Audio League does not possess a crystal ball, and it cannot solve problems in human relations. But, in addition to publishing reports, we will print information which will enable the consumer to select the components for a balanced system at a price he can afford. We will present what we think are reasonable criteria for selection expenditure. We will try to keep you up-to-date on the latest developments which may cause obsolescence. (At this time we will state that disc recording and playback, and magnetic pickup cartridges will remain the mainstay of hi-fi reproduction for the home for quite some time to come, and that we do not now know of anything radically new which will obsolete present techniques.)

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WHY AN AUDIO LEAGUE ? Cont.

We will tell you how to put your system together for the best results, once you have it home, and we will try to tell you how to remain happy with it. Some of us forget that music once was composed to be heard for esthetic reasons, and not to titillate the thresholds of pain or audibility.

NUMBERS AND NOTIONS

There are at least two aspects to sound reproduction; the physical and the psychological. Physical quantities (such as hum, noise, gain, distortion, power, impedance, etc.) can be measured and presented as numbers and graphs. Even at that, two investigators may obtain different results, or one investigator may obtain different results upon repeating his measurements. A measurement may be considered satisfactory if all the pertinent conditions of the measurement are known and stated so that the measurement may be repeated in the same place or in any other place, by the same person or bydifferent people, with the same results. This basic condition for a test is called repeatability.

Given the results of a number of repeatable measurements on a piece of audio equipment; do they completely describe the 'listenability' of the equipment? The answer is no. More accurately, it is not known whether the numbers and graphs completely describe the equipment's listenability. There are many psychological and psychoacoustic factors, some of which are known (such as the Weber-Fechner Law, the Fletcher-Munson effect, etc.) and some of which are as yet unknown, which must be taken into account in order to completely describe the properties of a piece of audio equipment.

Certain measurements have extremely poor correlation to listening quality; loudspeaker impedance measurements are an example . As audio technology advances, new methods of test and measurement will be devised and shown to have reasonable correlation with the psychological and psychoacoustic factors. Such a test is the intermodulation distortion test, which was found to have much closer correlation with listening quality than does harmonic distortion analysis. As such new tests are introduced, The Audio League will employ them. But in the meantime we must do what can be done. The state of the audio art is such that a complete description of listenability can be made only by listening. Even though the listener may not know the factors that determine listening quality, he automatically includes them (rather, he cannot exclude them) when listening.

Since the individual listener may be biased, various precautions must be taken in order to obtain results which are as objective as possible.

'A-B' tests must be employed, and listening panels must be chosen to include representative samplings of ages, musical tastes, and opinions. The theory and practice of listening tests is an interesting subject, and one which will occupy attention in the audio field until exact methods of measuring listening quality are developed.

NEEDS AND WANTS

Possibly the largest problem that besets one about to purchase an audio system for his home, is the problem of knowing what he should want. In other words, he needs criteria for selecting his equipment; not the make, but the kind. There are high-power enthusiasts who point out that one needs a 50-watt or 100-watt amplifier to reproduce the instanteous peaks, and there are low-power enthusiasts who point out that your speaker cone will be damaged if you have a 50-watt amplifier, and anything untoward occurs. The low-power fellows will explain the enormous power of even one acoustic watt, and will advise you to buy a ten-watt amplifier and to invest your saving in a better (speaker, cartridge, turntable, etc.)

Let us take an example from another field. Chevrolet, Ford and Plymount each have models priced under two-thousand dollars. Cadillac, Chrysler and Packard have models priced over thirty-five hundred dollars. All of the lower-priced cars provide satisfactory transportation, and all will exceed most speed limits. Since they perform the same general functions, some people conclude that the low-priced cars are 'better' because they cost less for what they give, and thus give more for what they cost. Such a conclusion implies that all consumers have the same income and the same tastes. The man with only two thousand dollars cannot fairly evaluate the merits of the cars he cannot buy. The man who has four thousand dollars to spend may place special value on having 235 horsepower under his hood, or on having a car which is 227 inches long, and these features may be worth the extra fifteen-hundred or two thousand dollars to him.

High-fidelity is a field in which psychological factors enter at least as much as in automobiles; here, too, certain satisfactions may be derived from owning expensive equipment with special features. The Report will supply complete information to guidethe purchaser with modest means; but it will not take away the pleasures of the consumer with the extra money and the fancy taste. In other words, we will not adversely criticise equipment merely because it is expensive. (In due time, we will cover both sides of the low-power vs. high-power controversy.)

TESTING AND EVALUATING POWER AMPLIFIERS

Initially, the amplifier is terminated in its rated load resistance (usually 8 ohms). If it has any controls, the volume is set at maximum and any tone controls are adjusted for flattest frequency response (not necessarily at their center positions, incidentally). The line voltage is accurately adjusted to 115 volts, since even small changes in line voltage may have a profound effect on the maximum power output of an amplifier.

The following tests are then performed:

a) The maximum power output which the amplifier will deliver at various frequencies is measured. The output waveform is viewed on an oscilloscope and the input signal increased until clipping or other distortion becomes barely visible. The output power at that point is considered to be the maximum power output of the amplifier at that frequency. This is one of the most important characteristics of an amplifier and frequently misleading power ratings are assigned by an overzealous manufacturer. It is of little use to have an amplifier which can deliver 20 watts at 1000 cycles and 5 watts at 30 and/or 15,000 cycles, since it will overload and produce large amounts of intermodulation distortion if an attempt is made to operate it near its maximum output. Such an amplifier (and there are still quite a number of them being sold) should in all honesty be called a 5-watt amplifier.

b) With the input signal adjusted to give 0.5 watts output at 1000 cycles, and maintained at that level, the frequency is varied over a wide range and the output of the amplifier plotted against frequency. This is the usual "frequency response" curve which gives an optimistic picture of the amplifier's performance, since almost any amplifier which might be seriously considered for a hi-fi system will be flat within 2 db from 20 - 20,000 cycles and usually well beyond these limits. This characteristic is only indirectly related to the power response referred to in (a) above, and a wide, flat frequency response is possible in an amplifier with very poor power handling capabilities. It is not generally appreciated, incidentally, that the frequency response curve should ideally fall off at both high and low ends sooner than the power response to minimize the possibility of unwittingly overloading the amplifier.

c) Intermodulation distortion is measured at power levels from a fraction of a watt to maximum output. There is not space here to discuss the subject of intermodulation distortion (IM), and more complete treatment of this subject will be forthcoming in a future issue of the Report. Suffice it to say here that this measurement most effectively correlates the audible distortion of an amplifier with easily measured electrical quantities.

d) Harmonic distortion is also measured at low and middle frequencies at various power levels. This test is made largely to check manufacturers claims, since it is merely a different and less concise method of describing the same non-linearities whose effects we have measured in the intermodulation tests.

e) Hum and noise voltage across the output load are measured with the input to the amplifier both open and shorted, and at maximum and minimum settings. Most manufacturers seem to rate their hum and noise outputs with the input shorted, since this usually gives a lower figure. This is fairly valid if a cathode follower (low impedance) driver is used in the preamplifier, but many preamps have high impedance outputs and the hum and noise level may be appreciably higher when using them. This quantity is expressed in decibels (db) below manufacturers rated power output or in db below a reference power level, such as 10 watts. We have found a disturbing tendancy on the part of some manufacturers to glibly claim "Hum and noise 96 db below 30 watts" and actually have a hum and noise level of 60 or 70 db below 30 watts, which is on the verge of being not acceptable in a quality music system. Actually, a hum and noise level of 70 db below 10 watts is virtually inaudible under home listening conditions and any amplifier which meets this requirement should be quite satisfactory. We merely appeal to the manufacturers (some of them, that is) and /or their ad writers for a little more objectivity in performance claims.

f) As a check on the stability margins of a feedback amplifier, a capacitor is shunted across the resistive load and increased until the amplifier oscillates, as seen on the oscilloscope. Such oscillation, when it occurs, is at a super-audible frequency, but can cause distortion (IM) which is quite audible. Much has been made of this problem

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THE WILLIAMSON STORY

What is the Williamson amplifier? We do not know of a single high-fidelity enthusiast who has not heard the name. A glance at the high fidelity catalogs of several distributors shows more than a dozen amplifiers which are represented as being "Williamson" or "Williamson-type". Their performance, as claimed by the manufacturers, is generally impressive but quite variable with typical extremes of distortion at a 10-watt level being 0.1% to 2%. Prices vary from under $50.00 to about $160.00.

Obviously, the amplifiers at the extremes of price and and performance mentioned here are not at all the "same kind of animal". Merely calling an amplifier "Williamson" does not make it one. Let us review the history of this famous amplifier and see just what is required of an amplifier before it can honestly be called a Williamson.

In 1947, D. T. N. Williamson, a British engineer interested in high fidelity sound reproduction, published an article in "Wireless World", outlining what he considered the basic design requirements of a good amplifier. Essentially, these were:

(1) Negligible distortion (harmonic and intermodulation) up to the maximum rated power output.
(2) Flat frequency response within the spectrum of **10 to 20000 cycles and constant power handl**ing capacity for negligible distortion at any frequency in the audible spectrum. Williamson, incidentally, was one of the first to point out the importance of having the frequency response fall off more rapidly than the power response. (See the discussion of Audio League test procedure in this issue).
(3) Good transient response, -in particular, the gain should not change due to current or voltage cutoff in any stage, to prevent spurious thumps and excessive overhangs on percussive sounds. This was to be accomplished in part by careful design of iron-core components, and by reducing their number to a minimum.
(4) Low output resistance, to improve speaker damping. If the output resistance of the amplifier is less than about a tenth of the speaker impedance, speaker overhang and muddy bass will be minimized.
(5) Williamson considered that realistic reproduction of orchestral music in an average room required a peak power capability of 15-20 watts with ordinary baffle-loaded loudspeakers.

Williamson commenced his design with the output stage. His conclusion, after a study of possible methods of developing 15-20 watts of output, was that push-pull triode tubes with negative feedback were the best solution to the problem. The negative feedback serves many functions - it reduces phase shift, distortion, output impedance, and the effects of tube and supply voltage changes, and it improves the linearity of the amplifier and its output transformer. Such a circuit could deliver the desired power with less than 0.1% harmonic distortion, far less distortion than the standards current in 1947. At the same time, the output impedance of the amplifier could be reduced to a fraction of an ohm.

This performance would have been impossible with any type of output stage without the use of negative feedback. Tetrodes could have been used with performance approaching that of triodes. The advantages peculiar to tetrodes are increased efficiency and lower drive voltage requirements. On the debit side, considerably more feedback is required in order for tetrodes to have an output impedance comparable to triodes, and considerably more care is needed in the design and construction of a tetrode amplifier if its full capabilities are to be realized.

If substantially more than 15 watts is required, or if a relatively low voltage power supply is to be used, tetrodes are a "must". Williamson considered that ease of operation and sure-fire performance were worth the cost of a high-voltage power supply (400-450 volts as against 350 volts or so on typical tetrode amplifiers).

Williamson chose the KT66 (a tetrode similar to the 6L6 but with high power ratings) as his output tube, with the screen grid and plate tied together to form a triode. These tubes were chosen both because of their excellent linearity in the triode connection and their unusually high plate dissipation rating (necessary because almost three-fourths of all the power put into the output tube plates must be dissipated as heat).

The design of the output transformer was one of the most vital steps in Williamson's development. At that time, virtually none of the commercially made transformers, either in this country or Britain, were suitable for exacting applications such as this. Although he specified a complete design, including winding instructions, his essential performance requirements included:

Primary inductance - 100 henries or more measured at 50 cps
Leakage inductance - 22 mh or less measured at 1000 cps

It is interesting to note that, in 1947, Williamson had to have his transformer specially constructed for him, while today a considerable number of manufacturers, both in the U.S.A. and Britain, produce excellent transformers, many of which considerably exceed the original specifications. Some (but by no means all) suitable transformers include those made by Acro, Chicago, Partridge, Peerless and U.T.C. If each of the aforementioned transformers were to be used in a properly constructed Williamson amplifier and the performance checked as to frequency response, power response and IM distortion, it would be found that, within the limits of 20-20,000 cycles and at power outputs of less than 10 watts, **virtually no difference would be measurable, let alone de**tectable by ear. (The Audio League has thus tested several makes of transformers and can vouch for this fact).When one considers the somewhat intangible performance of an amplifier at subsonic and ultrasonic frequencies, there are considerable differences, of course, as well as when the amplifier is "pushed" for outputs of 15 or 20 watts. In general, "the more you pay, the more you get", with transformers as with anything else.

The difficulties of applying considerable feedback around more than one transformer led Williamson to specify R-C coupling between all the stages preceding the output stage. He considered several phase-splitting circuits, eventually choosing a split load phase inverter, driven by a direct coupled state of amplification. This circuit, while by no means the only possible choice for this application, has some outstanding advantages, namely

(1) Extreme simplicity
(2) Potentially perfect balance, depending only on the tolerance of the plate and cathode resistors
(3) Elimination of one R-C coupling due to the direct coupled driver - this is important in obtaining stable operation with heavy feedback.

Many articles have appeared in the literature in recent years, purporting to show that this or that circuit is superior to the split load circuit, because of better balance in the megacycle region or other far-fetched reasons. The important things to remember in evaluating these claims are:

(1) Balance is important in the audio spectrum of 20-20,000 cycles. Elsewhere, extreme unbalance may cause instability; moderate amounts, at frequencies of hundreds of kilocycles, where the gain of the amplifier may be down to the vanishing point, are of no concern whatever.
(2) Simplicity is one of the cardinal virtues of good design. No vacuum tube phase inverter has fewer components than the one which Williamson chose, and the fewer parts we use, the less trouble we will have with them.

A conventional push-pull triode driver was used between the phase inverter and the output stage. The final result was an amplifier having only 4 tubes, 1 transformer and 33 other assorted resistors and capacitors, which delivered about 15 watts with 0.1% harmonic distortion over the entire audio spectrum, 20-20,000 cycle, and considerably beyond. This distortion was a tenth of that found in many of the finest amplifiers of that day, and has still not been surpassed. Furthermore, any amplifier circuit we have seen which claimed performance comparable to Williamson's original design requires more components than his.

In 1949, the Williamson was more or less formally introduced to the United States as the "Musician's Amplifier" by Sarser and Sprinkle in an article in Audio Engineering. They made no essential changes, merely substituting American tube types for the English types originally specified, and a Peerless output transformer for the specially constructed Williamson unit. They chose 807's to replace KT66's in the output stage because their dissipation rating was approximately the same. Electrically, there are not significant differences (within the range of normal Williamson amplifier operation) between the 6L6, 5881, 807 or KT66. However, the 6L6 cannot be recommended since it will not withstand the high (25 watt per tube) dissipation encountered in a Williamson. At reduced voltage, such as 350. an output of 6 or 7 clean watts can be gotten from 6L6's. The 807, while otherwise suitable, is awkward because of its plate caps and size. The KT66, of course, is ideal for this application, and recently we have noted a swing to the 5881, an extremely rugged and compact American type. Almost all currently available Williamson amplifiers use either 5881's or KT66's.

More recently, we have seen the "ultra-linear" amplifier introduced by Acro, makers of a specially designed transformer, used in that circuit. It has been claimed that merely substituting their transformer in a Williamson circuit will double the power output, reduce distortion, etc. These claims are generally true, at least insofar as Acro transformers are concerned. These are excellent units, giving remarkable performance for their size and weight (but they are not cheap). The maximum power output is doubled, indeed,'though up to 10 watts or so there is no significant improvement in distortion. Still, it is nice to have an extra 3 db of reserve power output available, and this is a convenient way of getting it. However - and this is important - any claims that the ultra-linear amplifier sounds "cleaner" than the orifinal Williamson are sheer advertising ballyhoo. Any amplifier (basic power amplifier, that is) having distor-

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TEST REPORT ON THE CRAFTSMEN C-500 AMPLIFIER

As we have seen in "The Williamson Story", there are a number of true Williamson amplifiers available today, all of them essentially equivalent in their audible performance. The Audio League feels that little would be accomplished by fully testing every make and model, so we have chosen what we consider to be a well-designed and constructed amplifier which fully lives up to the letter and spirit of Williamson's basic design.

The Craftsmen C-500 has been on the market for several years, and was one of the first Williamson amplifiers to be manufactured in this country. Its circuit differs from Williamson's original only in the values of some of the coupling capacitors, which have been changed to provide a greater margin of stability against low frequency oscillation or motorboating. It is claimed that its output transformer equals or surpasses the requirements set forth by Williamson (see page 3). Judging from the results of our tests, there seems to be no reason to doubt these claims.

Physically, the C-500 is constructed on a single chrome-plated chassis. The contribution of chrome-plated surfaces to listening enjoyment is debatable but it is a fact that the C-500 chassis is a handsome sight and relatively easy to keep clean and dust-free. This is an important item if the amplifier is exposed to view on a shelf or table, a fairly common practice.

The output tubes are KT66's with 6SN7's being used in the earlier stages. Originally a 5V4G rectifier was specified, but in current production (known as C-500A) this has been changed to a 5U4. The C-500A is an improved model which should be more reliable than the original model. A number of resistors have been replaced by higher wattage units, and the power supply has been completely redesigned. A larger power transformer is used, together with a choke input filter. This is highly desirable from the standpoint of rectifier tube life, but is not too common in competitively priced amplifiers due to the need for a higher voltage power transformer. Further changes include a different case on the output transformer (we don't know if the transformer itself has been changed; however, nothing in the measured performance indicates this) and numerous ventilating holes in the chassis, which should contribute to longer life for the under-chassis components.

The Audio League tested three units - an early C-500, one of the later C-500 models, and a C-500A. As may be seen from the power and frequency response curves in this issue, they are substantially identical. The slight variations in high frequency performance can be attributed to wiring capacitance and small variations in transformer characteristics. We feel that the uniformity of these characteristics, spanning several years of production, shows a commendable efficiency in the Craftsmen quality control department.

The disparities between the maximum power output of the amplifiers are insignificant, being due largely to differences in plate voltage resulting from different rectifier tube characteristics, and possibly to differences in the individual output tubes themselves. They are all close enough to the manufacturer's 15 watt rating to be considered acceptable.

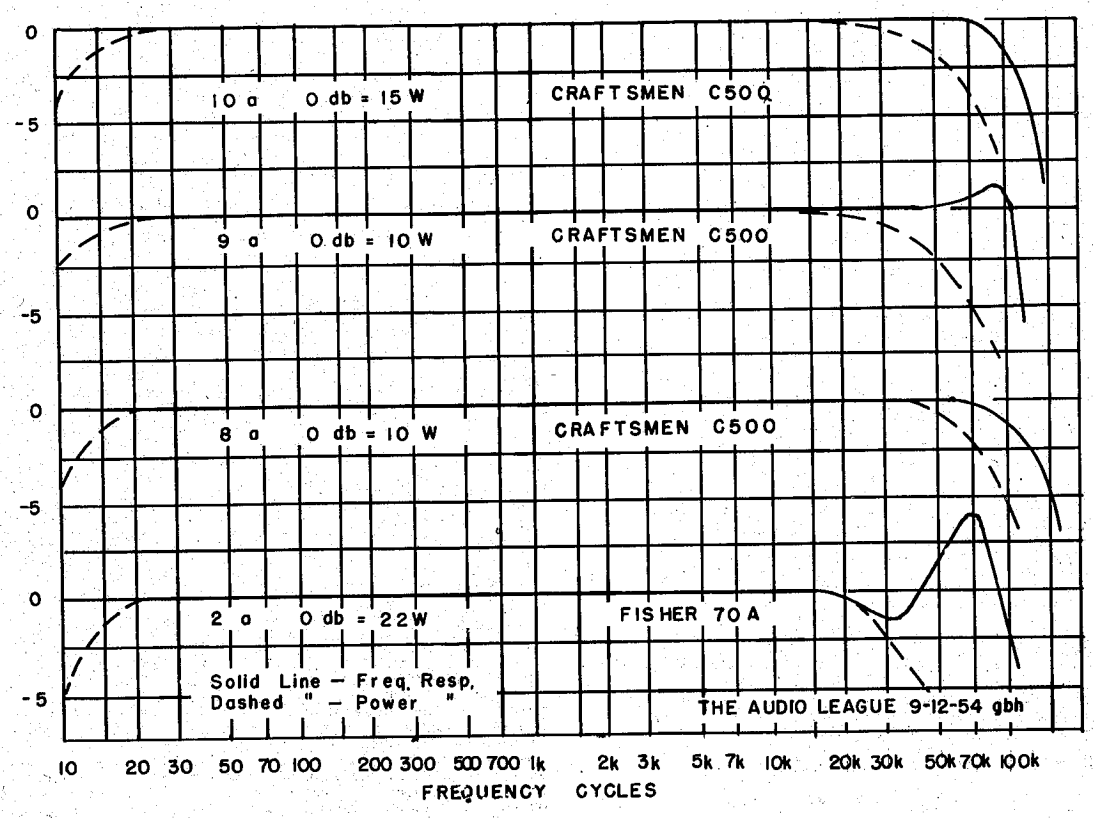
Much has been written about the instability of certain feedback amplifiers with capacitive loads. We are happy to report that we found it impossible to make any of the C-500's oscillate with any value of capacitance up to 1 microfarad across their output terminals.

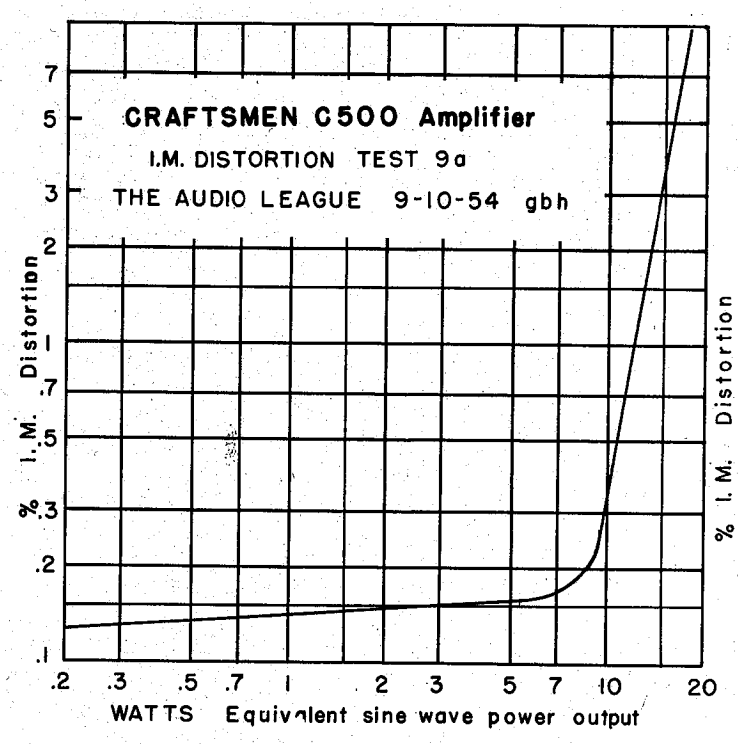
The IM distortion curves were so nearly alike that only one is reproduced here. Within the limits of our measurement techniques, the claimed distortion figures appear to have been achieved. Especially worthy of note is the fact that our measurements of hum and noise level on all three units confirm the advertised claim of 90 db below 10 watts. Very few equipments which we have tested have been honestly rated in this respect. Since even 80 db below 10 watts is completely inaudible through the finest speaker systems, the C-500 can be said to provide up to 15 clean, distortion-free watts over a range far exceeding the audible spectrum, with absolutely no audible hum or hiss.

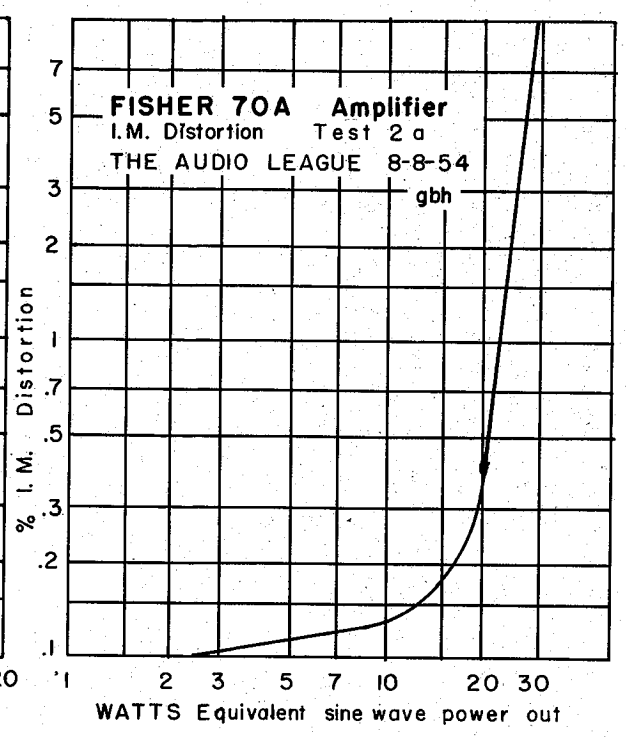
Lest it be thought that we are overdoing our enthusiasm for the C-500, we assure our readers that there are a number of other Williamson amplifiers and still others of different circuit design which are equally meritorious. Since we have not fully tested some of them, we hesitate to recommend them as unqualifiedly as we do the C-500, but until and unless we receive information to the contrary, we would rate the following basic power amplifiers as being audibly equivalent for home use:

Brociner UL-1, Brook 10C, Brook 12A, Fisher 50A, Fisher 70A, Grommes 215BA, Grommes 230BA, Hallmark, Leak TL/12, McIntosh A-116, McIntosh 50W-2, Pilot AA-901, Scott 220A, White 1010, White 1020.

Omission of any make or model from the above list does not imply disapproval by The Audio League.







TEST REPORT ON THE FISHER 70-A POWER AMPLIFIER

When the Fisher 70-A amplifier was announced a year ago, we were somewhat surprised and not a little skeptical. At a price of $99.50, an unusually compact 25 watt amplifier with remarkably low distortion and hum level, bearing the name of a manufacturer as reputable as Fisher, quite naturally caused a raised eyebrow or two among our staff.

Since then the Audio League has tested a 70-A in accordance with the procedure described elsewhere in this issue. We are pleased to report that this amplifier lives up to its manufacturer's claims in every important respect.

Physically, the 70-A is deceptively small--7 1/8" deep, 10 1/4" wide, and 6 1/8" high. Its appearance is handsome and the workmanship is excellent throughout. A bottom cover is provided, as on all Fisher equipment. A word of caution is in order here; lest the user be tempted to squeeze the compact 70-A into a space just large enough to receive it. This amplifier gets HOT, so we recommend that several inches be left clear on all sides and adequate ventilation provided. In other words, don't try to install the Fisher 70-A in any space that will not accommodate a Craftsmen C-500, Pilot AA-901, or other standard size amplifiers. You would be inviting trouble from early tube and component failures.

A single high impedance input is provided, and output terminals for an 8 or 16 ohm speaker load. The only control is a screw driver adjusted level setting potentiometer, which would normally be set upon installation and left alone. An easily replaced fuse is provided.

The Fisher , up to the output stage, employs fairly conventional Williamson circuitry. A 12AT7 first stage and split-load phase inverter is followed by a push-pull 12AU7 driver. The output stage, push-pull 5881's, is the source of the amplifier's unusual performance. The tubes are tetrode connected, and the output transformer has special windings for the cathodes, screens and plates of the output tubes. If Fisher were given to inventing fancy names (which, fortunately, they are not,) it might well be termed an "Ultra-Ultra-Linear" amplifier. Fisher states that the transformer consists of fifteen interleaved windings on a grain-oriented steel core. Considerable negative feedback is applied around the transformer, in addition to internal feedback, resulting in a low internal impedance.

The results of our frequency and power response measurements are plotted on the same co-ordinates as the C-500, to facilitate comparison between the two amplifiers, whichare identically priced although the 70-A is considerably smaller and almost twice as powerful.

It will be noted that the 70-A exhibits a fairly prominent output transformer resonance at 70kc. in contrast to the smooth roll-off of the C-500. A resonance of this sort is typical of wide range power amplifiers with overall negative feedback, and is not particularly objectionable if held to a reasonable amplitude and well outside the audible range. Absence of a resonant peak may provide somewhat better transient response as evidenced in a square-wave test, but again this is of doubtful significance at a frequency of 70kc. At the low end all the amplifiers are flat to 10 cps, which is as low as we went.

The low frequency power handling capacity of all the amplifiers is essentially the same, being down 3db at 11-13cps. Remember, though, that 0db for the Fisher is 22 watts, while 0db for the C-500 is 10 watts. Since the -3db point on a power response curve represents half power. the 70A can deliver 11 watts at 11 cps, compared to 5 watts for the C-500 at the same frequency. Above 20cps both amplifiers can deliver their full power through the entire audio range up to 20 kc. The 70-A high frequency power response curve falls off much more rapidly than that of the C-500, but it can still put out more actual undistorted watts up to 40 kc.

Fisher's published frequency response curves do not show the resonant peak, but are otherwise accurate. We don't know why they are ashamed to show the 3.8 db peak at 70 ck--it is perfectly inocuous--but they have not. Not an important item, in any case. Their power curve, identified as "Power Response at 20 and 25 watts Output", departs considerably from our test results. Undoubtedly their test consisted of setting up for an output of 20 or 25 watts at 1000 cycles or some such frequency and, while varying the frequency, reading the output power without regard for waveform distortion. We feel that this type of measurement has no significance whatever. For example, their curves show the power response down 1 db at 10 cps and 40 kc. The Audio League found that the power response (namely, available undistorted power) was down 1 db at 16 cps and 25 kc. Once again, (at the risk of being repetitious), it doesn't matter which measurement is valid for a home

Continued on P.6

music application. However, if one desired to generate some ultrasonic energy in the 40-50 kc region, for example, the 70-A would fall far short of what one would be led to expect by the published data.

Summarizing these response curves, the Audio League is of the opinion that the 70A and the C-500 are substantially identical in their response from 20-20000 cps, with the 70A having a 2:1 advantage in available power output.

The intermodulation Distortion Tests (henceforth referred to as I.M.) show the true differences between these amplifiers in a most striking fashion. The "break point", at which distortion begins to rise rapidly, occurs at 8-9 watts in the C-500 and about 17 watts in the 70-A. Eight watts is the normal break point for a conventional Williamson amplifier, corresponding to the point at which the output tubes begin to draw grid current and require power instead of merely voltage to drive them.

Up to the 8-9 watt level both amplifiers are quite similar, having I.M. distortions of not more than 0.2%. It would appear that the Fisher shows some superiority in this respect, since its distortion becomes unmeasurably low below 3 watts, while the C-500 has a residual distortion of 0.1% or so. However, any measuring technique is subject to error, especially when dealing with such infinitesimal distortion levels as these, and we would not claim that any significant differences between the amplifiers are shown by the distortion curves below a 5 watt level. We will not deny, however, being impressed by the 70-A measurements (we re-checked them carefully at that time, doubting our own technique!) The 2% I.M. distortion level is 14 watts for the C-500 and 25 watts for the 70-A.

As we have stated in the description of our test procedure, we shunt the output of each amplifier with a capacitance in parallel with a resistive load to determine if the amplifier will oscillate under these conditions. When the 70-A was loaded with a 0.35 uf capacitor in parallel with an 8 ohm resistor, it oscillated at a superaudible frequency. With 0.25 uf, or less, it was stable. It would require over 2 miles of speaker cable to load the amplifier in this fashion, so we would say that the 70-A is designed with adequate safety margins.

Fisher states that 1.4 watts will drive the 70-A to full output. We found that 1.1 volts input resulted in 22 watts output, which was the single frequency output at which distortion just became visible on an oscilloscope.

The manufacturer claims less than 0.5% harmonic distortion at 25 watts, 0.15% at 20 watts, 0.05% at 10 watts. The Audio League found that the total harmonic distortion at 400 cycles was 0.22% at 22.5 watts, 0.03% at 19.4 watts, and less then 0.01% at 16.6 watts--all substantially better than the advertised claims.

We viewed with suspicion the Fisher claim of a hum and noise level 95 db below full output (presumably 25 watts) since we have encountered several extremely exaggerated claims for low hum level by other manufacturers. Remember, 70 db below 10 watts is barely detectable by the ear, -80 db is completely inaudible, and levels of better than -85 db call for extreme care in design and layout. The small size and self-contained power supply of the 70-A caused us to be somewhat dubious as to their claims. With the level control fully advanced, we measured a hum and noise level 76 db below full output (22 watts for the unit we tested). When the control was turned fully off the hum and noise dropped to 91 db below 22 watts. This latter condition of operation is not unreasonable, since driving this amplifier from a cathode follower stage such as is found in the better tuners and preamplifiers will load down its input circuit and give much the same effect as turning down the level control.

Expressed relative to 25 watts, this hum and noise level becomes -92 db, which we feel sufficiently close to the claimed -95 db to be accounted for by normal tube and layout variations. Incidentally, a listening test on a speaker system with extremely good bass response showed no audible hum whatsoever and only the faintest hiss in a quiet room when the ear was pressed against the tweeter horn. As Fisher puts it, "hum and noise are virtually non-measurable..." Very true.

To summarize, the Fisher 70-A is a superior amplifier in every respect, and an outstanding value for the money. The Fisher Radio Corporation is to be commended for honesty and restraint in their advertising and performance claims, as well as for publishing complete performance data so the prospective purchaser may evaluate them for himself.

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We are sure that after reading this Report, a question has arisen in the minds of many of our readers as to whether the C-500, (or another Williamson amplifier) or the 70-A, would be a better choice. We hesitate to take any dogmatic stand on this question. On the basis of measured performance, the 70-A is clearly more amplifier for the money. On the other hand, at any conceivable home listening level, they are essentially equivalent, and we do not believe that any audible difference could be discerned between the two amplifiers--both of which are outstandingly free from "listening fatigue." If you listen at ear shattering levels, or have an inefficient speaker system, or a 25x40 foot living room, buy the Fisher. If your system is mounted exposed to view, the chromed C-500 presents an exceedingly handsome appearance. Perhaps you can make a better "deal" on one or the other. Of one thing you can be sure--you won't go wrong on either.

HARMAN-KARDON "FESTIVAL"

Advertisements have recently appeared introducing the Harmon- Kardon D-1000 "Festival" -- an AM/FM tuner, preamplifier, and Williamson type power amplifier in one chassis complete with power supply. We liked the idea, the claims were glowing, so we obtained one for test. Although many of its features are most praiseworthy, we found so many discrepancies between its measured performance and the manufacturer's claims that we would like to test another unit before rendering our report. It is hoped that other units will not have the serious faults found in the one examined. Watch for our Report in the near future.

INTERELECTRONICS CORONATION SUPRA-LINEAR AMPLIFIER

Originally advertised last year at a $92.50 price tag and now being more heavily advertised at $99.50, the rather grandiosely titled Coronation "Supra-Linear" amplifier sounds like qite a package even in today's somewhat overcrowded amplifier market.

Featuring "Supra-Linear" Williamson circuitry and a chrome plated chassis,this handsome and compact gem seems to be the answer to an audiophile's prayers. The advertisements speak of I.M. distortions of a fraction of a percent at 15 watts, a full 30 watts available output, a hum and noise level 95 db below 30 watts,and so forth.

Well, sad to say, all is not chrome that shines... although the Coronation chassis is indeed a handsome piece of work. It is built on a long narrow chassis in much the same manner as the Pilotone AA-902 though it is somewhat larger. Nevertheless, it is extremely compact and no doubt could be installed in many locations which could not accommodate a more conventionally proportioned unit,

First,let us look at the sunny side of the story. The components under the chassis are all mounted on a single terminal board and are easily the most accessible and neatest layout we have seen. A unique feature is that all the components likely to need periodic replacement are mounted in such a manner that they can be plugged into sockets-- not only the tubes but also the electrolytic filter and decoupling capacitors which are in a single plug in can. The tube lineup is conventional Williamson with 6SN7's and KT66's. The "Supra-Linear" feature is a variation on the Ultra-Linear circuit, with separate windings for the screens instead of tapping them off the plate windings.

On the other hand, we found the I.M. distortion to be several times as high as claimed, although still quite good by any reasonable standards. The power output, far from being 30 watts, was about 21 watts (the only way we could come near the claimed figure was to boost the line voltage to 130 volts when the output was 28 watts). The fault was that the plate voltage was too low, being only 415 volts with the 130 volt line. A redesign of their power transformer might well make their advertised performance a reality.

The hum level was far worse than their -95 db claim. With the input shorted the hum was -87 db relative to 30 watts(an unattainable power, remember), but with the input open, or rather terminated in the internal half megohm resistor, the hum rose to -66 db. This was quite audible in an ordinary speaker system and would have been most annoying on a system with extended bass response.

This is one amplifier which could profit from a little more engineering and some objective ad writing. As we have said, we like its trim appearance, accessability, and many little evidences of thoughtful design that can be found in it. It has only one serious drawback-- it won't do anywhere near as well as its builders claim for it.

We have seen ads for a new Interelectronics preamplifier whose performance is claimed to be as startling as that of their power amplifier, and will try to obtain one for test in the near future. Watch for the full report on both of these units in the Audio League Report soon.

THE WILLIAMSON STORY Cont.

tions of the order of one or two tenths of a percent, at 10 watts output and a damping factor of 10 or more, sounds exactly like any other at any level useable in the home since distortions of this order are, first, probably undetectable by the human ear and, secondly, are completely masked by the far greater distortions generated in other parts of the reproducing system.

Apparently Acro's patent position was not too secure, because most other manufacturers have since come out with similar circuits, even calling them "ultra-linear". We have not tested all of these, but a word of caution is in order. Merely connecting the screens to taps on the output transformer primary does not make an amplifier "ultra-linear". The transformer windings must be wound with close coupling between the different portions of the primary for correct performance. In other words, it must be designed for the job and not be a re-hash of a conventional output transformer. As an example, the writer attempted this conversion on his Partridge WWFB transformer (one of the best there is, by the way), and although the taps were at the proper impedance level, and the output was indeed doubled, the distortion was also increased several times. Needless to say, the original circuit was speedily restored and we are happily using our old original Williamson.

Finally we come to the $64. question - what can we properly call a Williamson amplifier and when does such an appelation constitute a fraud on the unsuspecting consumer?

It is our considered opinion that an amplifier which adheres to Williamson's original circuit in its essentials, and which meets or exceeds his performance criteria, is entitled to be called a Williamson. (Refer to C-500 report). This specifically includes the "ultra-linear" versions such as the Pilot AA-901 and the Brociner UL-1 circuits, which actually exceed Williamson's specifications on power output.

It does not include so-called "Williamson-type" amplifiers such as Pilot's AA-902 and AA-903, which use tetrode output tubes with relatively little feedback, and have ten times the distortion of a true Williamson.

There are many excellent amplifiers on the market which do not use the Williamson circuit, yet are in every way its equivalent in listening performance and laboratory measurement. This group includes the Fisher, Leak, McIntosh and Quad amplifiers, to mention only a few. These excellent units are able to stand on their own merits, without drawing on the reputation of Williamson's name. Remember - most "Williamson-type" amplifiers are not Williamson amplifiers by any stretch of the imagination.

At the beginning of this article, we commented on the price range of the various Williamson amplifiers. Our earlier statement about getting what you pay for still applies - except that we should be sure to know what we want. For all practical home listening purposes, the $39.75 Heathkit W4 is as good as the $160. British Hallmark. The latter should last a lifetime, without requiring service, -it is doubtful if this could be said of any other. Slightly more power and a more handsome appearance can be had by paying $90. to $130. for any of several excellent amplifiers. To a considerable extent, one pays for a manufacturer's name or for some "snob appeal" factor.

The whole subject can best be summarized in a quotation from Williamson himself, which originally appeared in Wireless World for September 1952:

"It will be appreciated from the foregoing that there are a large number of solutions to the problem of designing a first class amplifier and no one of these solutions can be called the best solution. Each has its advantages and disadvantages, and the individual designer must choose that which most nearly meets his needs. The 'goodness' of an amplifier is not shown by its circuit diagram. Circuits have no inherent magic properties, but are merely the tools with which the designer seeks to achieve a certain result, and different designers, provided always that they have the same high standards in view, may achieve the same result by different means."

TO OUR READERS

We have been very pleased by the large number of favorable comments received along with your subscriptions. Apparently, many persons interested in hi-fi have looked forward to a publication such as this and are actively telling their friends about us. There is no doubt that if you give us the subscription support we need, we will merit your confidence and enthusiasm. The more subscriptions we have, the better job we will be able to do for each of you. We want to take this opportunity of thanking you for your good wishes since we do not have the time to thank you individually.

Many of the subscribers have written to us with special requests for information on specific equipment and some have wanted an analysis of their equipment. We are sorry but it would be impractical for us to attempt, at this time, to answer each such request. However, we will attempt to answer such questions as seem to be of general interest in future "Question and Answer" columns to the extent that space permits. We will also attempt to publish information and comments of general interest sent in by you from time to time. Your cards and letters do receive our attention and are reviewed to ascertain how we can best serve your needs. Please continue writing us your comments, questions, and suggestions. Please show this issue to your friends and get them to send in their subscriptions.

TESTING AND EVALUATING POWER AMPLIFIERS (Cont.)

in recent articles and ads by UTC, since a long line feeding a speaker may introduce considerable capacitance in the output load. None of the amplifiers tested by the Audio League have oscillated with any reasonable capacitance load,and some (notably the (Craftsmen C-500) simply could not be made to oscillate. We feel this to be a considerably overrated problem, but will continue to test all amplifiers in this fashion.

g) A number of miscellaneous tests and examinations are made, including the input voltage needed to develop maximum output, plate dissipation of output tubes (as an indication of a conservative or a skimpy design), physical details such as wiring, types of components used, layout, dimensions, weight, temperature rise of transformers, resistors, etc.

In general, not all of the above listed tests are reported on, though all are performed. In any case where we feel that a particular unit is decidedly better or worse than one might reasonably expect, we comment in detail. In other words, "no news is good news" in an Audio League Report.

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The format of the Audio League Report may change from issue to issue. Your suggestions and comments along these lines would be appreciated. As the number of subscribers increases, we expect to continue to improove the method of "duplicating" the report. At our current rate of growth it should not be too many issues before the Report could be fully printed. Against the cost of printing however, must be considered the desireability of increasing the number of pages per issue. We are loaded with material that you have indicated you want to recieve. Which should come first, printing or enlargement?

PLEASE NOTE

Correspondents desiring a reply must enclose a self-addressed stamped envelope or postcard. No reply will be made unless the same is enclosed.

COMING SOON

Next month we expect to report on the new Heathkit W4M Williamson amplifier and the re-styled and re-designed Heathkit preamplifier. We also will feature an article on the general subject of equalization which we hope will dispell some of the fogginess connected with that esoteric topic.

Coming in future issues will be reports on the Fisher 70RT tuner, Harman-Kardon 'Festival', Coronation 'Supre-Linear' amplifier, Scott 121A preamplifier, and the new National line of Hi-Fi equipment. Please write us your preferances for future equipment reports.

From

The Audio League
P.O. BOX 55
PLEASANTVILLE, NEW YORK

This Copy For.